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(54) **ANTENNA CORE, ANTENNA, AND METHODS FOR PRODUCING AN ANTENNA CORE AND AN ANTENNA**

(76) Inventors: **Johannes Binkofski**, Rodenbach (DE); **Markus Brunner**, Bessenbach (DE); **Klemens Trabold**, Elsenfeld (DE); **Ralf Koch**, Freiensteinau (DE)

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H01F 41/02	(2006.01)
H01Q 1/22	(2006.01)

(Continued)

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CPC ***H01Q 7/08*** (2013.01); ***H01F 1/15333*** (2013.01); ***H01F 3/04*** (2013.01); ***H01F 41/0226*** (2013.01); ***H01F 41/0691*** (2013.01); ***H01Q 1/2216*** (2013.01); ***H01Q 7/06*** (2013.01); *Y10T 29/49016* (2015.01)

(58) **Field of Classification Search**
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USPC 343/787, 788, 713; 29/600
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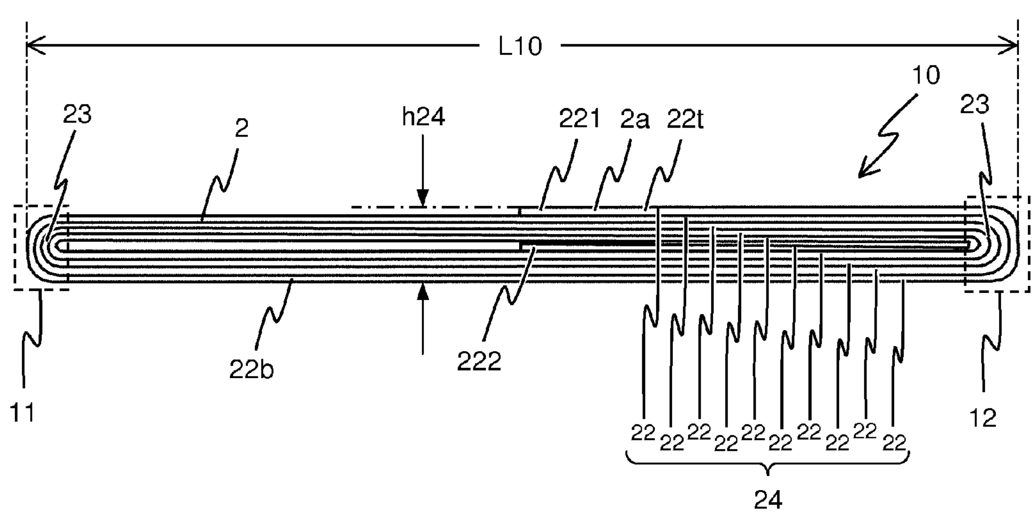
Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Dickinson Wright PLLC

(57) **ABSTRACT**

The invention relates to an antenna core, an antenna comprising an antenna core, and to methods for producing an antenna core and an antenna. The antenna core used in each case consists of a continuous soft-magnetic strip having a plurality of layers which are stacked one on top of the other and each of which is formed by a section of the strip. The layers are connected to one another by curved sections of the strip at end regions of the antenna core.

51 Claims, 4 Drawing Sheets



(51) **Int. Cl.**

H01Q 7/06	(2006.01)
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H01F 1/153	(2006.01)

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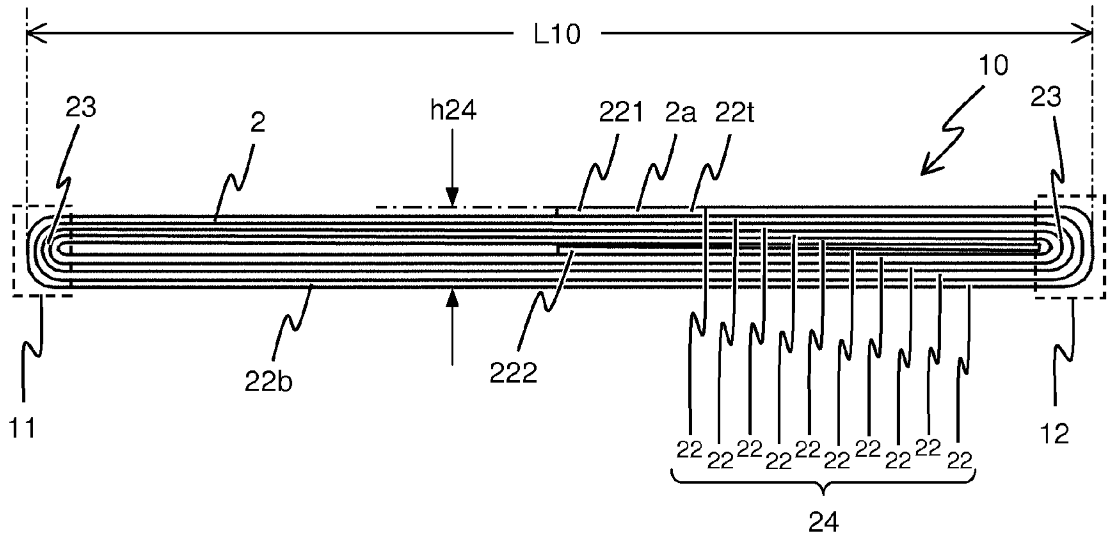
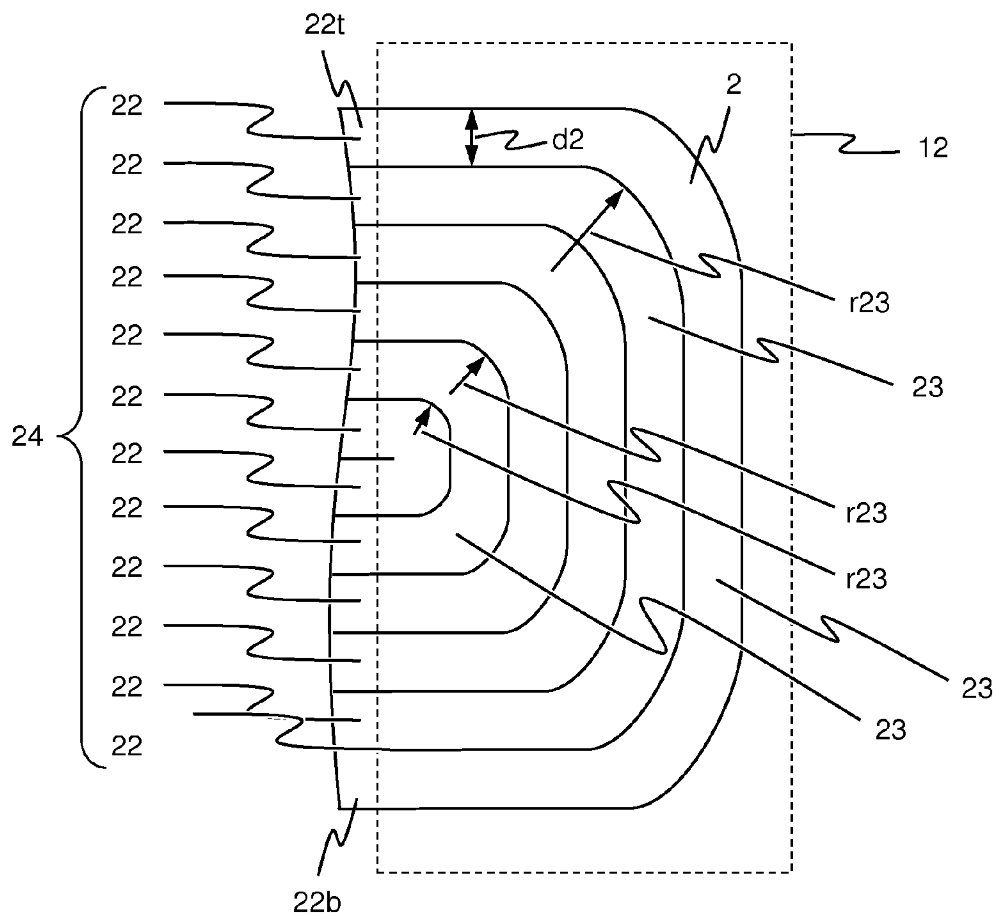

L10
10
23
2
h24
221
2a
22t
23
11
22b
222
12
22
22
22
22
22
22
22
22
22
22
24

FIG 1


22t
2
d2
12
22
22
22
22
22
22
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22
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22
22
22
24
r23
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r23
r23
23
23
22b

FIG 2

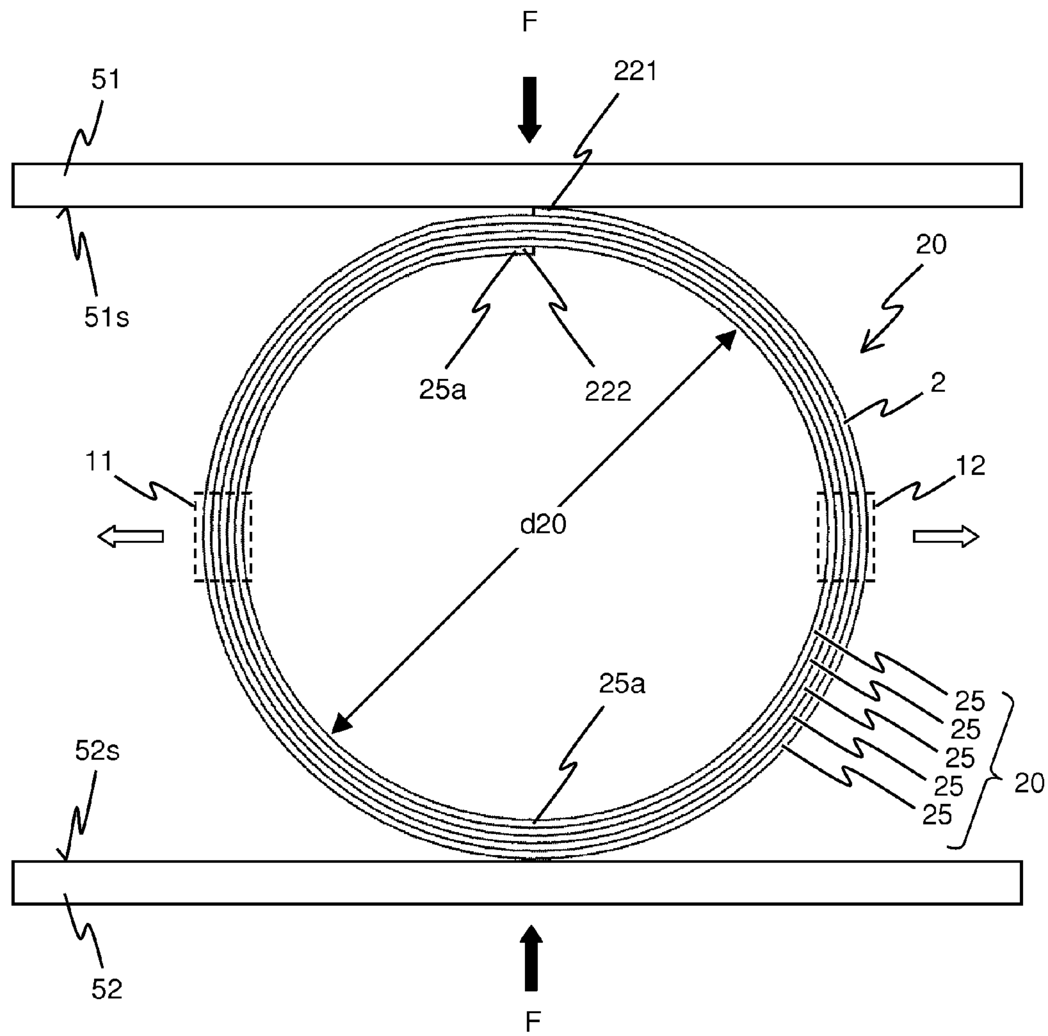
F
51
221
51s
20
25a
222
2
11
12
d20
25a
25
25
25
25
25
20
52s
52
F

FIG 3

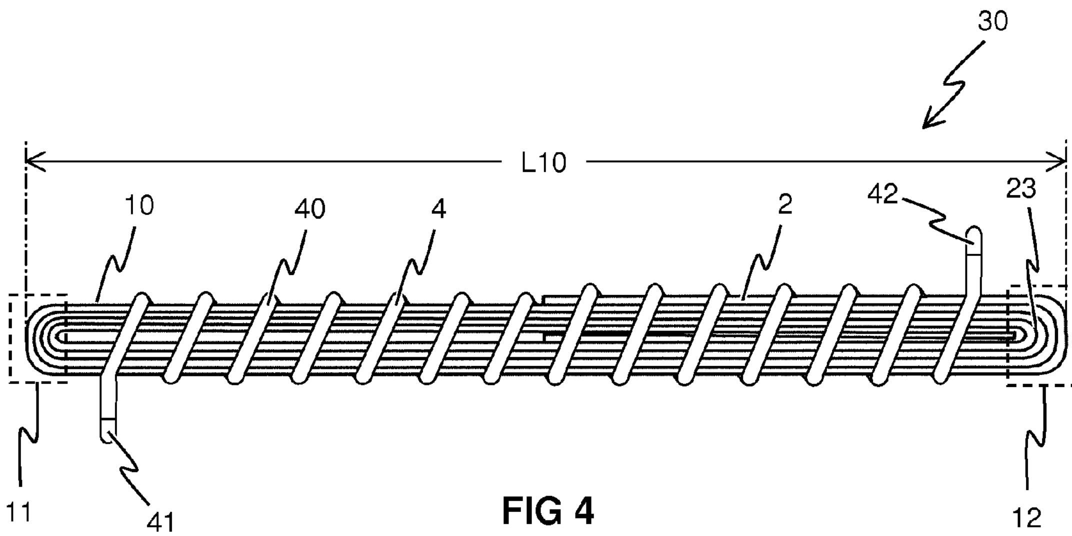
30
L10
10
40
4
2
42
23
11
41
12

FIG 4

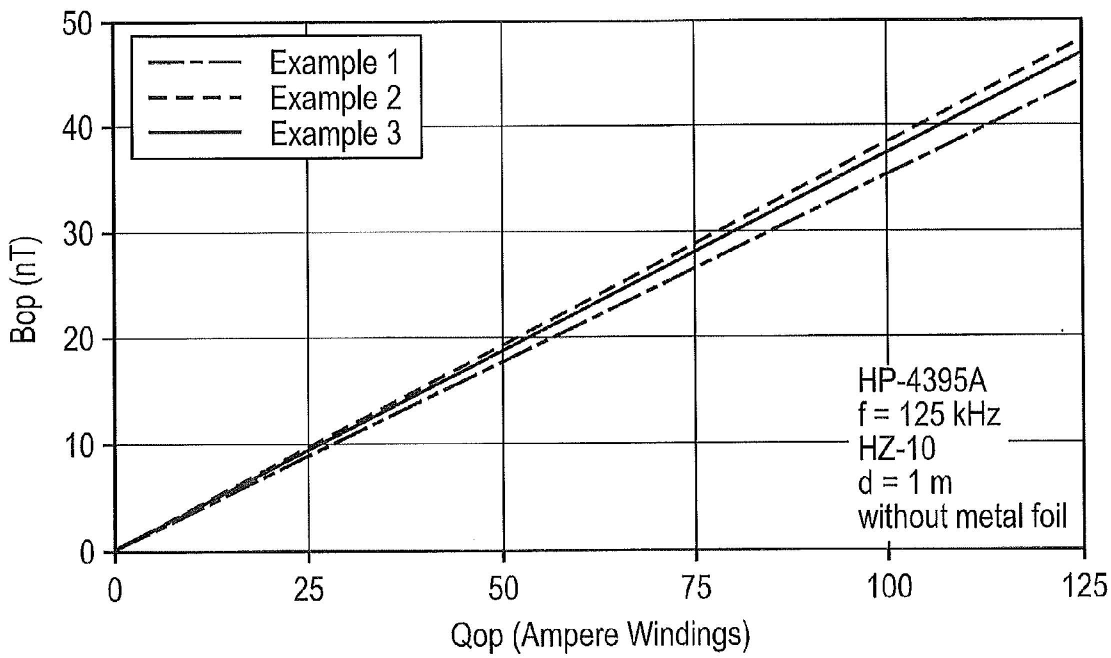
Example 1
Example 2
Example 3
Bop (nT)
Qop (Ampere Windings)
HP-4395A
f = 125 kHz
HZ-10
d = 1 m
without metal foil
0
10
20
30
40
50
0
25
50
75
100
125

FIG. 5

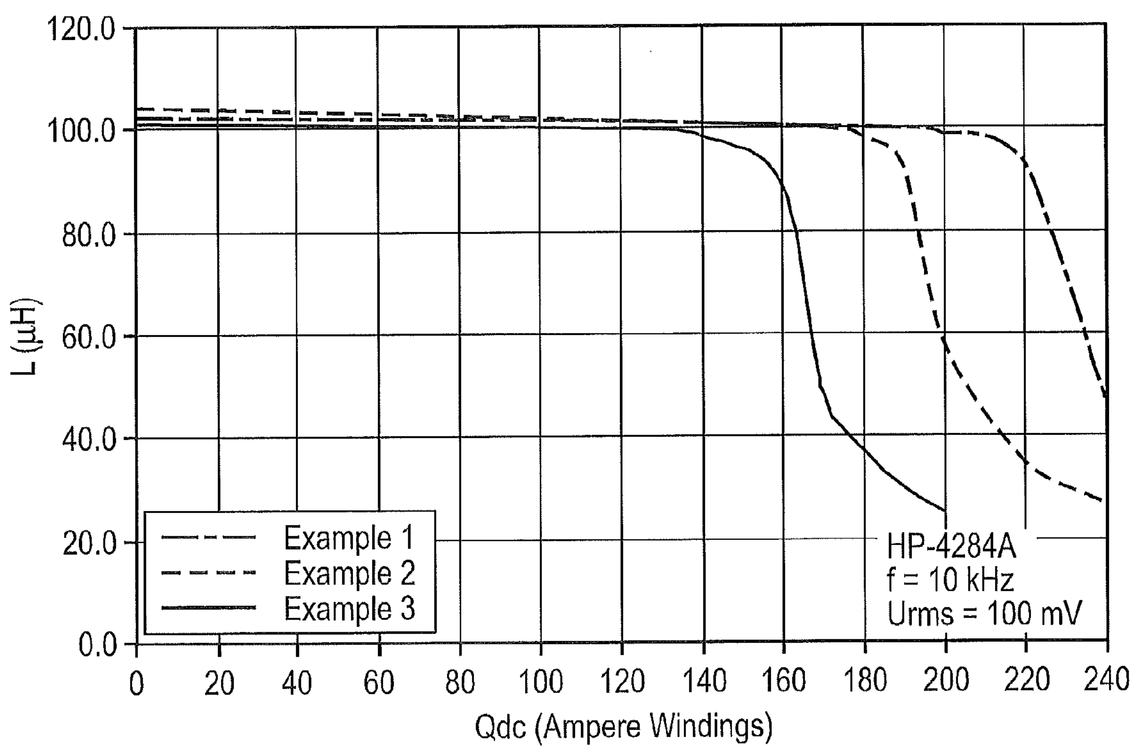
Example 1
Example 2
Example 3
L (μH)
Qdc (Ampere Windings)
HP-4284A
f = 10 kHz
Urms = 100 mV
0.0
20.0
40.0
60.0
80.0
100.0
120.0
0
20
40
60
80
100
120
140
160
180
200
220
240

FIG. 6

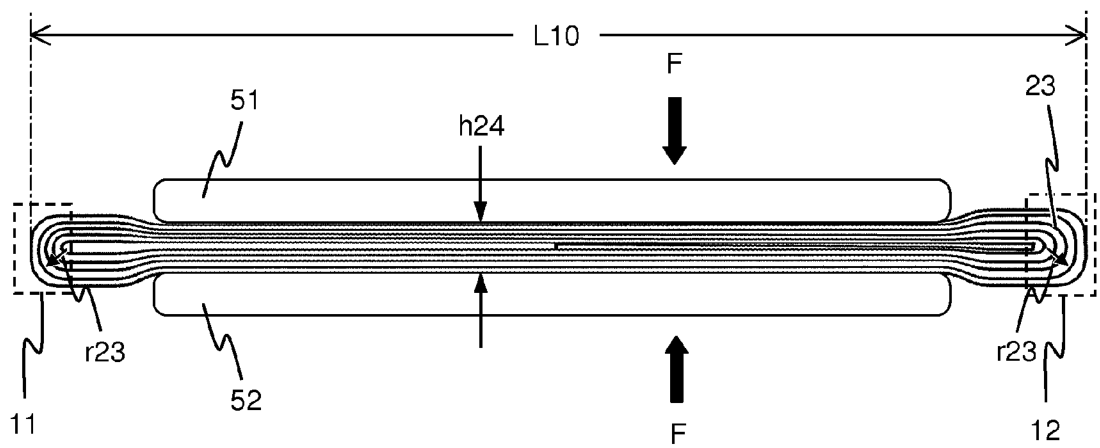

FIG 7

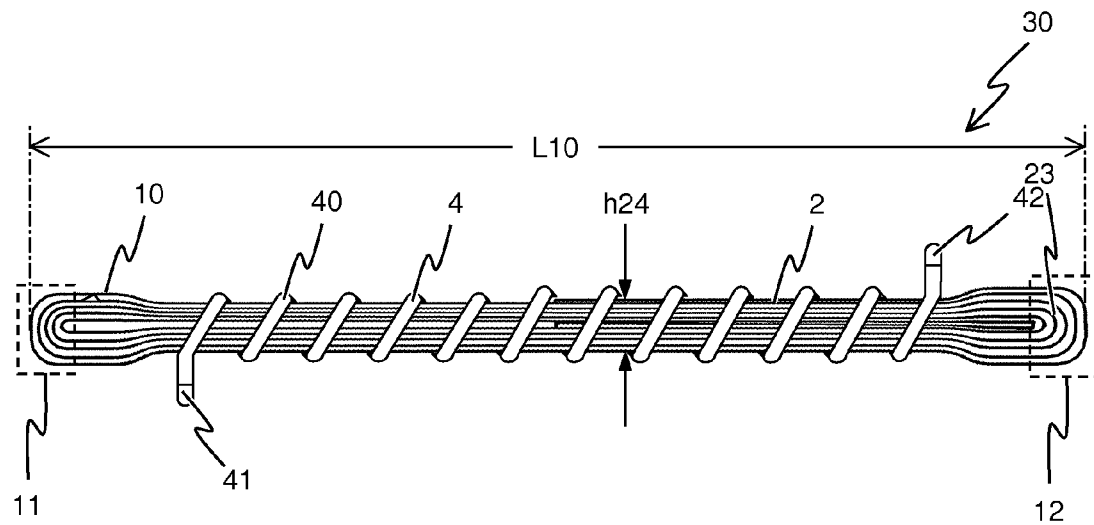

FIG 8

ANTENNA CORE, ANTENNA, AND METHODS FOR PRODUCING AN ANTENNA CORE AND AN ANTENNA

BACKGROUND

1. Field

Disclosed herein are antenna cores and antennas, as they are used in recognition systems, e.g., in keyless entry systems. Such recognition systems can be used in the most varied technical applications. Locking systems in automotive applications, entry control systems for safety-relevant areas, etc., can be mentioned only by way of example.

2. Description of Related Art

The antenna cores or antennas are used as transmitting antennas for generating a magnetic field. The antennas are generally operated in a resonant oscillating circuit, which is tuned by matching a series capacitor and/or a series resistor to the impedance of the antenna arrangement at the desired transmitting frequency. In this case, antennas with the highest possible quality are usually used, which, however, requires a high expense for the tuning of the resonance circuit.

In the simplest case, such a transmitting antenna can be designed with a ferrite rod core of any cross-section. Due to the high isotropic volume resistance of this magnetic material alone, high quality and low magnetism reversal losses are achieved with no special additional measures.

It may be necessary, however, for the constructed space available for the accommodation of the antenna to limit the antenna cross-section and/or to require a bent or bendable antenna. Because of their poor elasticity and the material-typical low saturation induction, ferrite rods are therefore unsuitable.

SUMMARY

It remains desirable, therefore, to provide an antenna core and an antenna that are mechanically flexible. In addition, these antennas are to make possible a high enough degree of transfer efficiency or a high enough transmitting field strength with simultaneously simple tuning of the resonant oscillating circuit. These and other advantages are achieved by embodiments of an antenna core and antenna disclosed herein.

An antenna core according to one embodiment comprises several layers of a through magnetic strip and has an elongated shape. The magnetic strip has a soft-magnetic alloy, which has an amorphous or a nanocrystalline structure. The antenna core has two end areas that are some distance apart, in which curved sections of the strip are arranged. Each of the layers is connected in at least one of the two end areas by such a curved section to another of the layers, whereby the curved section is designed integrally with the two layers which it connects. If such an antenna core is arranged inside an electrical coil, a flexible antenna is produced. In one embodiment, the individual strip layers of the antenna core are not isolated from one another, but rather consist of electrically conductive compounds between the layers at the ends of the antenna core.

The production of an antenna core can be carried out, for example, such that a through strip that consists of a soft-magnetic alloy, which has an amorphous or a nanocrystalline structure, is wound into a winding body with multiple windings. The innermost of these windings has two sections that are opposite one another, which come to rest against one another after the flattening of the winding body. The layers of the antenna core are produced from the windings during flattening. By wrapping such an antenna core with a wire, an

electrical coil is produced, in which the antenna core is arranged. The antenna core and the coil together form an antenna.

In comparison to the conventional rod antennas, as they are used in, e.g., keyless entry systems, such an antenna **30** shows lower quality and higher losses, which according to conventional wisdom are exactly what should be avoided in conventional systems. Surprisingly enough, however, it has been shown that in the typical, pulsed operating method of keyless entry systems, the low losses and high quality previously regarded as necessary in conventional systems are not required.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the antenna core are explained by way of example below with reference to the attached figures. Here:

FIG. **1** is a schematic diagram that shows a side view of an antenna core that is wound from a magnetic strip;

FIG. **2** is a schematic diagram that shows an enlarged cutaway of the view according to FIG. **1**, which shows the right end area of the antenna core;

FIG. **3** is a schematic diagram that shows a winding body that consists of a magnetic strip, from which the antenna core that is shown in FIG. **1** is produced;

FIG. **4** is a schematic diagram that shows a side view of an antenna that is produced based on the antenna core according to FIG. **1**;

FIG. **5** is a graph that indicates the strength of the magnetic field for various alloy compositions of an antenna that is designed according to FIG. **4**, a magnetic field that can be reached at a specific distance from the antenna under imposed boundary conditions;

FIG. **6** is a graph that shows saturation behavior for various alloy compositions of an antenna core that is designed according to FIG. **1**;

FIG. **7** is a schematic diagram that shows an antenna core corresponding to FIG. **1** during flattening, whereby the metal plates **51** or **52** that are used for flattening are shorter than the length of the flattened antenna core; and

FIG. **8** is a schematic diagram that shows a side view of an antenna that is produced based on the antenna core according to FIG. **7**.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

The detailed description below relates to the attached drawings in which based on specific configurations, it is explained in what way the invention can be carried out. Directional information used in this case, such as, e.g., “above”, “below,” “ahead,” “behind,” “front,” “rear,” etc., is used relative to the orientation of the figures that are explained. Since the elements in the configurations can be arranged in a number of various orientations, such direction-linked terminology is used only for descriptive explanation and is in no way understood to be limiting. It is pointed out that this invention can also be produced based on other, unexplained configurations with use of the explained principles. In addition, it is pointed out that the features of the various configurations that are described below by way of example can be combined with one another, if not expressly mentioned otherwise, or if not, the combination of specific features is ruled out for technical reasons.

FIG. **1** shows an antenna core **10**, which has an elongated shape and which has a length L**10** in its longitudinal direction. The antenna core **10** is produced from a long, flat strip **2** that consists of a soft-magnetic alloy, which has an amorphous or a nanocrystalline structure. The soft-magnetic alloy can be produced, for example, by means of a quick-setting method. The thickness of the strip **2** can be, for example, 10 μm to 30 μm.

The antenna core **10** comprises several layers **22** that are stacked to form a layer stack **24** and that in each case are formed by a section of the through strip **2**. The use of several layers **22** leads to a high flexibility of the antenna core **10** in the direction in which the layers **22** are stacked. For this purpose, the antenna core **10** can also be inserted into, e.g., curved receiving areas. In the position of the antenna core **10** that is shown in FIG. **1**, each of the layers **22** is essentially flat. The height h**24**, which the layer stack **24** has, is also referred to below as stack height h**24**. The stack height h**24** is determined between two end areas **11** and **12** that are spaced some distance apart in the longitudinal direction of the antenna core **10**, such that the stack height h**24** is essentially equal to the product of the number of layers **22** of the layer stack **24** and the thickness d**2** of the strip **2**.

The end areas **11**, **12** are characterized in that in each case, several curved sections **23** of the strip **2** are arranged on each other in them. Each of the layers **22** is connected at at least one of the end areas **11**, **12** by one of the curved sections **23** to another layer **22**. In this case, the curved section **23**, which connects the two layers in question to one another, is designed integrally with the latter.

With the exception of the top layer **22***t* of the layer stack **24** and the bottom layer **22***b* of the layer stack **24**, each of the layers **22** is arranged between two other layers **22** and at each of these two other layers **22** has a distance d**22** that is smaller than the strip thickness of the soft-magnetic strip that is used for the production of the stack. Since adjacent layers **22** lie and generally rest directly on one another, the distance between them is normally equal to zero. Gas inclusions can also be located, however, between adjacent layers **22**, e.g., from the gas of the atmosphere surrounding the antenna core **10**, or inclusions from a solid body, which was introduced specifically between certain layers **22**, e.g., to make it possible to fasten the antenna core so that adjacent layers **22** are locally spaced some distance apart. Such gas inclusions can be caused by, for example, an unavoidable waviness of the strip **2**. Optionally, the possibility also exists in each case to isolate two adjacent layers **22** from one another specifically by a dielectric to avoid eddy current losses. Such a dielectric can be, for example, a film, or an oxide layer that is generated on the surface of the strip **2**.

FIG. **2** shows an enlarged view of the right end of the antenna core **10** that is shown in FIG. **1** with the end area **12**. The thickness of the strip **2** is referred to as d**2**. The curved sections **23** that are arranged in the end area **12** have a curvature radius r**23** in each case at at least one point. In this case, the curvature radius r**23** of at least one of the curved sections **23** can be smaller at at least one point than ten-times the strip thickness of the soft-magnetic strip that is used for the production. In addition, the curvature radius r**23** of each of the curved sections **23** can be smaller in each case at at least one point than five-times the value produced from the stack height of the antenna rod.

Below, a method for the production of such an antenna core **10** is explained by way of example in FIG. **3**. From a flat soft-magnetic strip **2**, first a winding body **20** is produced with a number of N25 windings **25** by the strip **2** being wound on a cylindrical or cylindrical-tubular section of a coil former (not shown). The inside diameter of the winding body **20** that is generated in this way is referred to as d**20**.

Then, the winding body **20** is removed from the coil former and clamped between plane-parallel sides **51***s*, **52***s* of two metal plates **51** and **52** and flattened under the action of a force F that acts on the metal plates **51**, **52** in such a way that a longer rod is produced, which forms the antenna core **10** that is shown in FIG. **1**. The subsequent end areas **11** and **12** are also shown in FIG. **3**. The direction of movement of the end areas **11**, **12** during the deformation of the winding body **20** is indicated in this case by the two open arrows.

The number N22 of the layers **22** of the finished antenna core **10** is in this case either equal to 2*N25 or equal to 2*N25+1, depending on where exactly the beginning **221** and the end **222** of the strip **2** come to rest.

An antenna **30**, as it is shown by way of example in FIG. **4**, is produced from such an antenna core **10** by the antenna core **10** being wound with a wire **4**. The wire **4** then forms a coil **40**, in which the antenna core **10** is arranged. The wire **4** can be, for example, a lacquer-coated wire, in which the lacquer at the ends **41**, **42** of the coil **40** is removed to make possible an electrical contact of the coil **40** and thus the antenna **30**.

Since the strip **2** for the production of the antenna core **10** does not have to be cut through, a very broad spectrum of alloys can be used for the material of the rod antenna. A limitation to the materials to those that allow the application of a sawing, cutting, punching or truncating technique is therefore unnecessary.

Below, based on three specific Examples 1, 2 and 3, it is explained how an antenna core **10** or an antenna **30** can be produced with the described method.

Example 1

In the simplest case, when the requirement for as small a magnetostriction as possible is eliminated, the strip **2** can consist of a soft-magnetic material, which in addition to typical contaminants of the commercially available raw materials or the melts essentially contains the alloy composition

$$Fe_aX_bSi_cB_d$$

whereby a, b, c and d are indicated in at. %; and whereby the following applies: $0 \le b \le 45$; $6.5 \le c \le 18$; $4 \le d \le 14$; $c+d>16$; and $a+b+c+d=100$. In this case, X can consist of cobalt, or nickel, or a mixture of cobalt and nickel.

For the first specific example, a flat strip **2** with a width of 12 mm, a thickness d**2** of 21 μm, and a nominal composition $FeSi_{12}B_9$ was used as strip **2**. The winding number N25 of the windings **25** of the winding body **20** produced from this strip **2** was 15 with a diameter d**20** of the winding body **20** of 75 mm. The number N22 of the layers **22** of the antenna core **10** that was produced after the deformation of the winding body **20** (see FIG. **1**) was 31.

After the deformation, this antenna core **10** was subjected to a heat treatment in extremely pure hydrogen at a temperature of 450° C. for a period of 3 hours. The antenna core **10** obtained in connection to this heat treatment had a maximum material permeability of 31,000 and a remanence ratio Br/Bs>0.5. The remanence ratio indicates the ratio of remanence Br to the saturation induction Bs.

With a rod antenna **30** that is formed from this antenna core **10** according to FIG. **4**, field strengths of 35 nT were reached at a frequency of 125 kHz and a modulation of 100 ampere windings of the coil **40** at a distance of one meter from the antenna **30**. FIG. **5** shows the dependency of the field strength reached at a distance of one meter from the antenna at a frequency of 125 kHz as a function of modulation. For

Example 1 that is explained, the bottom curve in FIG. **5** is significant. In this example, the antenna quality at a frequency of 125 kHz is less than 28.

Example 2

Another embodiment is based on an alloy composition that, aside from typical contaminants of the commercially available raw materials or the melts, essentially has the composition

$$Fe_aX_bCu_cSi_dB_eM_fZ_g.$$

In this case, M comprises at least one of the elements V, Nb, Ta, Ti, Mo, W, Zr and Hf. Z comprises at least one of the elements P, Ge and C. X can consist of cobalt, or nickel, or else a mixture of cobalt and nickel. The parameters a, b, c, d, e, f and g are indicated in at. % with $0 \le b \le 45$; $0.5 \le c \le 2$; $6.5 \le d \le 18$; $5 \le e \le 14$; $1 \le f \le 6$; $d+e>16$; $g<5$; and $a+b+c+d+e+f+g=100$.

For Example 2, the following specific nominal composition was selected for the material of strip **2**:

$$FeCo_{0.5}Cu_{0.98}Nb_{2.28}Si_{15.7}B_{7.1}$$

The soft-magnetic strip **2** that is used had a width of 12.3 mm and a thickness d**2** of 19.5 μm. The diameter d**20** of the winding body **20** was in turn 75 mm with a number N25 of 20 windings.

After the deformation of the winding body **20** to form a flat, elongated antenna core **10** (FIG. **1**), a heat treatment in extremely pure hydrogen was performed at the antenna core **10**. In this case, to obtain a nanocrystalline volume proportion of more than 50%, it is necessary to allow the antenna core **10** to mature in a temperature range of 480° C. to 600° C. In this production step, the originally very high magnetostriction of approximately +25 ppm or more is simultaneously reduced to values of considerably less than +10 ppm.

Specifically, in this Example 2, a one-hour maturation at a temperature of 558° C. was selected. In this connection, a magnetostriction λ_s in the range of 0 ppm to 0.2 ppm and simultaneously a maximum permeability of 285,000 as well as a remanence ratio Br/Bs>0.5 were set in the antenna core **10**.

With the rod antenna **30** (FIG. **4**) produced from this antenna core **10** by winding with a wire **4**, field strengths of 48 nT were reached at a frequency of 125 kHz and a modulation of 125 ampere windings at a distance of one meter. The antenna quality at this frequency was less than 30. The top curve in FIG. **5** shows the dependency of the field strengths reached in turn at a distance of one meter from the antenna **30** at a frequency of 125 kHz on modulation.

Example 3

In another embodiment of the invention, an alloy that has the following composition is used as a magnetic material:

$$Co_a(Fe_{1-x}Mn_x)_bNi_cX_dSi_eB_fC_g$$

whereby X is at least one of the elements from the group V, Nb, Ta, Cr, Mo, W Ge and P. The parameters a, b, c, d, e, f, and g are indicated in at. %. They meet the following conditions: $40<a<82$; $2<b<10$; $0<c<30$; $0<d<5$; $0<e<15$; $7<f<26$; $0<g<3$; $15<d+e+f+g<30$; as well as $0<x<1$.

As a specific composition for Example 3, a strip **2** with the nominal composition $CoFe_{4.7}Si_{5.6}B_{17.2}$ was selected. The width of the strip **2** was 10 mm; its thickness d**2** was 20.5 μm. The number N25 of the windings **25** of the winding body **20** was 20; the number N22 of the layers **22** of the antenna core **10** was 41. The inside diameter d**20** of the winding body **20** was in turn 75 mm.

The winding body **20** (FIG. **3**) was first subjected for a period of 4 hours to a heat treatment at a temperature of 365° C. During the heat treatment in the heat treatment space, a magnetic d.c. field was generated by means of a magnetizing coil that surrounds the heat treatment space. The orientation of the d.c. field was parallel to the winding axis of the winding body **20**, i.e., perpendicular to the plane of projection relative to FIG. **3**. In this connection, the magnetic material of the winding body **20** was magnetized until magnetic saturation took place.

The winding body **20** that was magnetized in this way was then deformed as described to form an elongated antenna core **10** according to FIG. **1**, and in this state, it was inserted into an injection-molding housing produced from polyamide to stabilize the desired form of the antenna core **10**. The finished antenna core **10** had a maximum material permeability of 1,600 and a remanence ratio Br/Bs<0.3.

With a rod antenna, produced from this antenna core **10**, according to FIG. **4**, field strengths of 45 nT were reached at a frequency of 125 kHz and a modulation of 120 ampere windings at a distance of one meter. The antenna quality at this frequency was <32. The mean curve in FIG. **5** shows in turn the course of the field strengths reached at a distance of one meter from the antenna **30** at a frequency of 125 kHz as a function of modulation.

Finally, FIG. **6** also shows the saturation behavior for each of the three antennas **10** explained in Examples 1, 2 and 3. Inductivity is plotted as a function of coil current.

According to another configuration, the flattening for the production of an antenna core **10** can be carried out with use of metal plates **51**, **52**, whose length is smaller than the length L**10** of the flattened antenna core **10**, which is shown in FIG. **7**. In this respect, it is ensured that the flattening of the antenna core **10** is carried out only between its end areas **11** and **12**, but outside of the latter. Thus, after the flattening, the antenna core **10** has a constriction. In this respect, excessive stress of the end areas **11**, **12** during flattening and thus a breaking of the strip **2** in the end areas **11** and **12** can be avoided. In such an antenna core **10**, at least one of the curved sections **23** can have a curvature radius r**23**, which is smaller than five-times, or smaller than two-times, or smaller than one-time the stack height h**24** of the strip (**2**).

FIG. **8** shows a finished antenna **30**, by an antenna core **10** according to FIG. **7** having been wound with a wire **4**, as was explained based on the antenna **30** shown in FIG. **4**. The winding in this case can be carried out in such a way that the coil **40** is arranged only in the constricted section of the antenna core **10**.

As was illustrated based on the preceding examples, a transmitting antenna can be produced with the proposed design of a rod antenna based on magnetic materials, which have very different properties with respect to maximum permeability and magnetostriction, which transmitting antennas can be produced extraordinarily economically and efficiently because of the small number and the simplicity of the necessary processing steps. The magnetism reversal losses that are increased by the metal-conductive connection at the ends **11**, **12** of the antenna rod **30** do not represent a disadvantage in applications that are operated in a pulsed manner. Rather, it was observed that the tuning of the circuit during operation of the antenna **30** in a resonant control circuit is facilitated by the increased antenna impedance and that a broader frequency band is available because of the reduced antenna quality.

By means of an antenna **30**, as it was described and explained in detail based on Examples 1 to 3, e.g., an above-mentioned keyless entry system or any other communication system can be produced in which a first communication partner and a second communication partner communicate with one another.

To this end, by means of a transmitting antenna that is designed according to a previously described antenna **30** and that is a component of the first communication partner, a magnetic field is generated in a preset frequency range, for example 9 kHz to 300 kHz, which is detected at a distance of a few meters by a receiving antenna, which is a component of the second communication partner. By the receiving of the magnetic field, communication between the first communication partner and the second communication partner is triggered in another frequency range, which can lie, for example, in the megahertz range. For communication in the other frequency range, the communication partners in each case can have another antenna, which is tuned to the other frequency range.

The antenna that is described in this application thus primarily has the object of generating a magnetic field in the kHz range. This offers essential streamlining and cost-saving measures in the production of the antenna and in the selection of magnetic materials that can be used in this respect. When energy is to be saved, savings are necessary or desirable the antenna can be operated not only continuously, but alternatively also pulsed.

Another advantage of the invention may result if the antenna with an antenna core that is designed according to this invention is operated in mobile applications. In conventional keyless entry systems primarily in automotive applications, it is common, for example, to use several short ferrite antennas in a motor vehicle to adequately cover the entire spatial area around the motor vehicle. Typically, the ferrite cores of these short antennas in each case have a length in the range of approximately 8 cm. Larger antennas with significantly longer ferrite cores are problematic primarily in mobile applications because of their high fragility. If, instead of this, antennas with antenna cores according to this invention are used within a motor vehicle, the latter can have considerably greater lengths in comparison to the above-mentioned ferrite cores. In this respect, in particular the transmission power of the individual antennas can be increased and thus correspondingly the number of antennas of a motor vehicle that is necessary for sufficient spatial coverage can be reduced. Thus, the length L**3** of an antenna core **10** according to this invention, for example, can also be selected greater than or equal to 150 mm or greater than or equal to 200 mm. In principle, even greater lengths L**3** of up to 500 mm or more than 500 mm are also possible. However, shorter antenna cores **10** with lengths of less than 150 mm can also be produced. Regardless of their length L**3**, antennas **30** or antenna cores **10** according to this invention can be used not only in automotive or mobile applications, but also in stationary operation.

The invention has been described with reference to certain specific examples and embodiments, which are intended to illustrate, but not limit, the scope of the appended claims.

The invention claimed is:

1. An antenna core, comprising:

an elongated shape having a plurality of layers of a through strip comprising a soft-magnetic alloy with an amorphous or nanocrystalline structure

two end areas disposed a distance apart at either end of the elongated shape, comprising curved sections of the through strip,

wherein each of the plurality of layers is connected in at least one of the end areas by a curved section of the through strip to another of the plurality of layers,

wherein the curved section connecting these two layers is integral with these two layers, and

wherein the through strip contains or consists of an alloy having the composition

$$Fe_aX_bSi_cB_d$$

wherein a, b, c and d are indicated in at. %; wherein X consists of cobalt, or nickel, or a mixture of cobalt and nickel, and wherein the following applies: $0 \leq b \leq 45$;

$6.5 \leq c \leq 18$; $4 \leq d \leq 14$; $c+d>16$, and $a+b+c+d=100$, and typical contaminants.

2. The antenna core according to claim **1**, wherein the plurality of layers form a layer stack, wherein, except for a top layer of the plurality of layers and except for a bottom layer of the plurality of layers, each of the plurality of layers is arranged between two other layers of the plurality of layers, and wherein a distance between a layer and each of these two other layers is smaller than a thickness (d**2**) of the through strip.

3. The antenna core according to claim **1**, wherein at least one of the curved sections has a curvature radius (r**23**) that is smaller than ten-times a thickness (d**2**) of the through strip.

4. The antenna core according to claim **3**, wherein at least one of the curved sections has a curvature radius (r**23**) that is smaller than five-times a thickness (d**2**) of the through strip.

5. The antenna core according to claim **1**, wherein each of the curved sections has a curvature radius (r**23**) that is smaller than five-times a stack height (h**24**) of the through strip.

6. The antenna core according to claim **5**, wherein each of the curved sections has a curvature radius (r**23**) that is smaller than two-times the stack height (h**24**) of the through strip.

7. The antenna core according to claim **6**, wherein each of the curved sections has a curvature radius (r**23**) that is smaller than the stack height (h**24**) of the through strip.

8. The antenna core according to claim **1**, wherein the through strip has a thickness of 10 μm to 30 μm.

9. The antenna core according to claim **1**, further comprising a constriction between the two end areas.

10. The antenna core according to claim **1**, having a length of at least 150 mm or at least 200 mm.

11. A method for the production of an antenna core according to claim **1** comprising:

preparing a through strip, comprising a soft-magnetic alloy with an amorphous or nanocrystalline structure;

winding the through strip to form a winding body with multiple windings, including an innermost winding having two sections of the through strip that are opposite one another;

flattening the winding body, so that the two sections of the innermost winding come to rest against one another.

12. The method according to claim **11**, wherein flattening the winding body comprises reducing the distance between the two sections of the innermost winding is smaller than the thickness (d**2**) of the through strip.

13. The method according to claim **11**, wherein flattening the winding body is carried out by means of two metal plates, whose length is smaller than the length (L**10**) of the antenna core after flattening such that the finished antenna core is constricted between two end areas.

14. The method according to claim **11**, further comprising heat treating the winding body before and/or after flattening in a temperature range of 350° C. to 600° C.

15. A method for the production of an antenna comprising:

preparing an antenna core, according to claim **11**;

wrapping the antenna core with a wire to product an electrical coil.

16. An antenna comprising an antenna core according to claim 1, and an electrical coil, in which the antenna core is arranged.

17. The antenna according to claim 16, whose quality is less than 32.

18. An antenna core, comprising:

an elongated shape having a plurality of layers of a through strip comprising a soft-magnetic alloy with an amorphous or nanocrystalline structure

two end areas disposed a distance apart at either end of the elongated shape, comprising curved sections of the through strip,

wherein each of the plurality of layers is connected in at least one of the end areas by a curved section of the through strip to another of the plurality of layers,

wherein the curved section connecting these two layers is integral with these two layers, and

wherein the through strip contains or consists of an alloy having the composition

$$Fe_aX_bCu_cSi_dB_eM_fZ_g$$

wherein M is at least one of the elements V, Nb, Ta, Ti, Mo, W, Zr and Hf; wherein Z is at least one of the elements P, Ge and C; wherein X is cobalt, or nickel, or else a mixture of cobalt and nickel; wherein a, b, c, d, e, f and g are indicated in at. %; and wherein the following applies: $0 \le b \le 45$; $0.5 \le c \le 2$; $6.5 \le d \le 18$; $5 \le e \le 14$; $1 \le f \le 6$; $d+e>16$; $g<5$; and $a+b+c+d+e+f+g=100$, and typical contaminants.

19. The antenna core according to claim 18, wherein the plurality of layers form a layer stack, wherein, except for a top layer of the plurality of layers and except for a bottom layer of the plurality of layers, each of the plurality of layers is arranged between two other layers of the plurality of layers, and wherein a distance between a layer and each of these two other layers is smaller than a thickness (d2) of the through strip.

20. The antenna core according to claim 18, wherein at least one of the curved sections has a curvature radius (r23) that is smaller than ten-times a thickness (d2) of the through strip.

21. The antenna core according to claim 20, wherein at least one of the curved sections has a curvature radius (r23) that is smaller than five-times a thickness (d2) of the through strip.

22. The antenna core according to claim 18, wherein each of the curved sections has a curvature radius (r23) that is smaller than five-times a stack height (h24) of the through strip.

23. The antenna core according to claim 22, wherein each of the curved sections has a curvature radius (r23) that is smaller than two-times the stack height (h24) of the through strip.

24. The antenna core according to claim 23, wherein each of the curved sections has a curvature radius (r23) that is smaller than the stack height (h24) of the through strip.

25. The antenna core according to claim 18, wherein the through strip has a thickness of 10 μm to 30 μm.

26. The antenna core according to claim 18, further comprising a constriction between the two end areas.

27. The antenna core according to claim 18, having a length of at least 150 mm or at least 200 mm.

28. A method for the production of an antenna core according to claim 18 comprising:

preparing a through strip, comprising a soft-magnetic alloy with an amorphous or nanocrystalline structure;

winding the through strip to form a winding body with multiple windings, including an innermost winding having two sections of the through strip that are opposite one another;

flattening the winding body, so that the two sections of the innermost winding come to rest against one another.

29. The method according to claim 28, wherein flattening the winding body comprises reducing the distance between the two sections of the innermost winding is smaller than the thickness (d2) of the through strip.

30. The method according to claim 28, wherein flattening the winding body is carried out by means of two metal plates, whose length is smaller than the length (L10) of the antenna core after flattening such that the finished antenna core is constricted between two end areas.

31. The method according to claim 28, further comprising heat treating the winding body before and/or after flattening in a temperature range of 350° C. to 600° C.

32. A method for the production of an antenna comprising:

preparing an antenna core, according to claim 28;

wrapping the antenna core with a wire to product an electrical coil.

33. An antenna comprising an antenna core according to claim 18, and an electrical coil, in which the antenna core is arranged.

34. The antenna according to claim 33, whose quality is less than 32.

35. An antenna core, comprising:

an elongated shape having plurality of layers of a through strip comprising a soft-magnetic alloy with an amorphous or nanocrystalline structure

two end areas disposed a distance apart at either end of the elongated shape, comprising curved sections of the through strip,

wherein each of the plurality of layers is connected in at least one of the end areas by a curved section of the through strip to another of the plurality of layers,

wherein the curved section connecting these two layers is integral with these two layers, and

wherein the through strip contains or consists of an alloy having the composition

$$Co_a(Fe_{1-x}Mn_x)_bNi_cX_dSi_eB_fC_g$$

wherein X comprises at least one of the elements from the group V, Nb, Ta, Cr, Mo, W Ge and P, and wherein a, b, c, d, e, f, and g are indicated in at. %; and wherein the following applies: $40<a<82$; $2<b<10$; $0<c<30$; $0<d<5$; $0<e<15$; $7<f<26$;
$0<g<3$; $15<d+e+f+g<30$; and $0<x<1$, and typical contaminants.

36. The antenna core according to claim 35, wherein the plurality of layers form a layer stack, wherein, except for a top layer of the plurality of layers and except for a bottom layer of the plurality of layers, each of the plurality of layers is arranged between two other layers of the plurality of layers, and wherein a distance between a layer and each of these two other layers is smaller than a thickness (d2) of the through strip.

37. The antenna core according to claim 35, wherein at least one of the curved sections has a curvature radius (r23) that is smaller than ten-times a thickness (d2) of the through strip.

38. The antenna core according to claim 37, wherein at least one of the curved sections has a curvature radius (r23) that is smaller than five-times a thickness (d2) of the through strip.

39. The antenna core according to claim **35**, wherein each of the curved sections has a curvature radius (r**23**) that is smaller than five-times a stack height (h**24**) of the through strip.

40. The antenna core according to claim **39**, wherein each of the curved sections has a curvature radius (r**23**) that is smaller than two-times the stack height (h**24**) of the through strip.

41. The antenna core according to claim **40**, wherein each of the curved sections has a curvature radius (r**23**) that is smaller than the stack height (h**24**) of the through strip.

42. The antenna core according to claim **35**, wherein the through strip has a thickness of 10 μm to 30 μm.

43. The antenna core according to claim **35**, further comprising a constriction between the two end areas.

44. The antenna core according to claim **35**, having a length of at least 150 mm or at least 200 mm.

45. A method for the production of an antenna core according to claim **35** comprising:

preparing a through strip, comprising a soft-magnetic alloy with an amorphous or nanocrystalline structure;

winding the through strip to form a winding body with multiple windings, including an innermost winding having two sections of the through strip that are opposite one another;

flattening the winding body, so that the two sections of the innermost winding come to rest against one another.

46. The method according to claim **45**, wherein flattening the winding body comprises reducing the distance between the two sections of the innermost winding is smaller than the thickness (d**2**) of the through strip.

47. The method according to claim **45**, wherein flattening the winding body is carried out by means of two metal plates, whose length is smaller than the length (L**10**) of the antenna core after flattening such that the finished antenna core is constricted between two end areas.

48. The method according to claim **45**, further comprising heat treating the winding body before and/or after flattening in a temperature range of 350° C. to 600° C.

49. A method for the production of an antenna comprising:

preparing an antenna core, according to claim **45**;

wrapping the antenna core with a wire to product an electrical coil.

50. An antenna comprising an antenna core according to claim **35**, and an electrical coil, in which the antenna core is arranged.

51. The antenna according to claim **50**, whose quality is less than 32.

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